

heated to 120 °C until stable pressure. The reactor was maintained at a slightly positive pressure. In succession, 125 ml of prepurified propylene was added under stirring. The reactor mixture was heated to 120 °C. At this reactor temperature, 1.5 ml of the premixed and preactivated catalyst solution was cannulated into the reactor using nitrogen. The catalyst solution consists of 32 mg of dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido)titanium dimethyl, 1.9 mg of rac-dimethylsilylbis(2-methyl-4-phenylindenyl)zirconium dimethyl, and 1.6 mg of dimethylsilylbis(indenyl)hafnium dimethyl, and 62.1 mg of N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate were dissolved in 50 ml of toluene. The polymerization was conducted for 15 minutes. Thereafter, the reactor was cooled down and vented to the atmosphere. The resulting mixture, containing mostly solvent, polymer and unreacted monomers, was collected in a collection box and first air-dried in a hood to evaporate most of the solvent, and then dried in a vacuum oven at a temperature of about 90 °C for about 12 hours. The resulting polymer (12.79 grams) showed a peak crystallization temperature by DSC of 102.9 °C, a glass transition (T<sub>g</sub>) of -8.7 °C, and a heat of fusion of 51.9 J/g. The average molecular weights, M<sub>n</sub>/M<sub>w</sub>/M<sub>z</sub>, are 33825/66387/267680.

#### Example 73-75 (comparative)

[00336] Three samples were made with rac-dimethylsilylbis(2-methyl-4-phenylindenyl) zirconium dimethyl or dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium dimethyl, following the general procedure described above except that only one catalyst was used. Rac-dimethylsilylbis(2-methyl-4-phenylindenyl) zirconium dimethyl was used to make isotactic polypropylene, while dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium dimethyl was used to make amorphous polypropylene. The experimental conditions and viscosity of polymer samples are presented in Table 15.

Table 15

Example	73	74	75
Catalyst	A	A	B
Catalyst feed rate (mol/min)	5.08E-06	5.08E-06	5.67E-07
Propylene feed rate (g/min)	14	14	14
Hexane feed rate(ml/min)	90	90	90
Polymerization temperature (°C)	130	125	110
Viscosity (cps) @190 °C	1132	2220	328
Catalyst			
A=dimethylsilyl (tetramethylcyclopentadienyl) (cyclododecylamido) titanium dimethyl			
B = rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) zirconium dimethyl			

[00337] Several samples from the preceding experiments were analyzed to determine their level of branching. For the purposes of this invention, the degree of branching is determined using the value of branching index  $g'$  at the molecular weight of  $M_z$  of the branched polymer. The results are presented in Tables 1 to 13.

[00338] Samples described in Example 4 and Examples 31-34 were fractionated using solvent extraction. The results are presented in Table 16. Selected fractionated fractions were analyzed using GPC-DRI-VIS-LS and DSC. The results from these analyses are also presented in Table 17. The complex viscosity profiles of the fractionated fraction from sample described in Example 31 were measured over the temperature range of 80 to 130 °C, are shown in Figure 5.

[00339] The sample described in Example 4 and its fractions extracted from solvent extraction were analyzed using  $^{13}\text{C}$  NMR.

[00340] Percent mm triad is measured directly from the C-13 NMR spectrum; it is assumed that the level of mm triad in the mixture depends only on the amounts of aPP and scPP ("atactic polypropylene and semi-crystalline

polypropylene, respectively") components in the sample. By knowing the tacticity (mm) level of the pure aPP and scPP components the proportion of each can be calculated that corresponds to the observed mm level in the mixture. The values shown below show the percentage of isotactic triads on a whole, unfractionated polymer as well as the three fractions. The calculated data are generated by using the assumption that the isotactic and atactic reference polymers are indicative of the tacticities that are in the blocky polymer segments. Using the methyl triad region it is calculated that the isotactic reference polymer has 94.7% mm and the atactic reference contains 13.6%.

Sample	%mm	% Calculated Isotactic Polymer
Unfractionated Polymer	68	66
Hexane Soluble	16	around 2%
Heptane Soluble	76	76
Heptane Insoluble	89	93

Table 16

Samples	Example 31	Example 33	Example 32	Example 34
Hexane room temperature solubles, wt. %	29.17	42.52	55.39	74.4
Soxhlet hexane soluble, wt. %	25.14	15.17	10.53	6.93
Soxhlet heptane soluble, wt. %	7.88	7.1	8.53	0.44
Soxhlet heptane insoluble, wt. %	35.32	35	25.15	17.8

Table 17

Example 4				
	Hexane room temperature solubles	Heptane soxhlet solubles	Heptane soxhlet insolubles	
Mn (kg/mol)	6.6	10.3	16.5	---
Mw (kg/mol)	14.3	30.2	31.3	---
Mz (kg/mol)	32.2	58.5	53.2	---
g' @Mz	1.16	0.86	0.87	---
Tc (°C)	---	105.2	112.8	---
Tm (°C)	---	138.2	145.2	---
Tg (°C)	-11.1	---	---	---
Heat of fusion (J/g)	0.0	68.6	108.9	---
Example 31				
	Hexane room temperature solubles	Soxhlet hexane solubles	Soxhlet heptane solubles	Soxhlet heptane insolubles
Mn (kg/mol)	9.5	20.9	20.1	20.8
Mw (kg/mol)	12.7	48	56.3	47.4
Mz (kg/mol)	25	131.5	148.8	150.2
g' @Mz	1.08	0.68	0.64	0.63
Tc (°C)	---	93.3	101.4	105.2
Tm (°C)	---	128.2	133.5	138.3
Tg (°C)	-11.8	-8.3	---	---
Heat of fusion (J/g)	0.0	52.5	66.1	70.7

[00341] The viscosity of products of Examples 12, 22 and 49 were measured over a temperature range of 80 to 130 °C. The complex viscosity profiles are shown in Figure 1. These data demonstrate the three-zone characteristics described above.

[00342] Selected samples and their blends were tested for adhesive performance. The pure polymers were compounded with tackifiers, oil or wax and stabilizer to form hot melt adhesive blends. The properties of these polymers and their blends were tested against typical commercially available EVA blends from Henkel and Chief. The blending was carried out under low shear at elevated

temperature to form fluid melts. The mixing temperatures vary from about 130 to 190 °C.

[00343] Escorez™ 5637 is a hydrogenated aromatic modified resin produced from dicyclopentadiene feedstock, exhibiting a ring and ball softening point of 130°C available from ExxonMobil Chemical Company in Houston, Texas.

[00344] Parafint H-1 is a Fisher-Tropsch wax exhibiting a molten viscosity of 10 mPa sec at 250 F, available from Moore and Munger.

[00345] Aristowax 165 is a refined paraffin wax available from Frank B Ross Co in Jersey City New Jersey. It is isolated from petroleum and has a melt point of 158 to 165 F.

[00346] Henkel Hot Melt 80-8368 is a commercial hot melt made from a blend of EVA's, tackifiers, and wax available from Henkel Corp.

[00347] MAPP 40 is a maleic anhydridemodified polypropylene, having an acid number of 50, a viscosity of 300 cps at 190 °C, a softening point of 149 °C, available from Chusei, USA.

[00348] Chief Hot Melt 268 is a commercial hot melt made from EVA, tackifiers, and wax available from Chief Adhesives.

[00349] KAYDOL® is a highly refined white mineral oil that consists of saturated aliphatic and alicyclic non-polar hydrocarbons having a pour point of -20°C, having a kinematic viscosity of 64 to 70 cSt at 40°C, available from Witco.

[00350] Licomont AR 504 is a maleic anhydride grafted polypropylene wax having an acid number of 41, a viscosity of 373mPas at 190° C, and a softening point of 156 °C available from Clariant.

[00351] AC 540 is an ethylene acrylic acid copolymer having an acid number of 40, a viscosity of 575 at 140 °C and a drop point of 105 °C available from Honeywell.

[00352] Polywax 2000 is a Polyethylene wax available from Baker Petrolite Plain BOPP (biaxially oriented polypropylene film) a 28 micron thick film was obtained from Mobil Films.

[00353] Corona treated BOPP (biaxially oriented polypropylene film) a 28 micron thick film was obtained from Mobil Films.

[00354] Paperboard 84A is gray Poster Board 20 pt chipboard with 20% recycle fiber available from Huckster packaging and supply, Inc. in Houston, Texas.

[00355] Paperboard 84B is generic poster board clay coated news print available from Huckster packaging and supply, Inc. in Houston, Texas.

[00356] Cardboard 84C is generic corrugated cardboard 200 # stock available from Huckster packaging and supply, Inc. in Houston, Texas.

Tradename	Description	Source
<b>Tackifiers</b>		
Escorez® 1102RM	C5 tackifier	ExxonMobil Chemical Company
Escorez® 2203	is a low aromatic modified hydrocarbon resin having a narrow molecular weight distribution produced from a feed of C5, C6 and C9 olefins and di-olefins, having a ring and ball softening point of about 95°C	ExxonMobil Chemical Company
Escorez® 2393	is a highly aromatic modified hydrocarbon resin produced from a feed of C5, C6 and C9 olefins and di-olefins, having a ring and ball softening point of about 93°C	ExxonMobil Chemical Company
Escorez® 2596	is a low aromatic modified hydrocarbon resin having a broad molecular weight distribution produced from a feed of C5, C6	ExxonMobil Chemical Company

	and C9 olefins and di-olefins, having a ring and ball softening point of about 96°C	
Escorez® 5637	is a hydrogenated aromatic modified resin produced from dicyclopentadiene feedstock, exhibiting a ring and ball softening point of 130°C	ExxonMobil Chemical Company
Escorez® 5690	is a hydrogenated aromatic modified resin produced from dicyclopentadiene feedstock, exhibiting a ring and ball softening point of 130°C	ExxonMobil Chemical Company
<b>Oils</b>		
Primol 352	Hydrogenated paraffinic oil	ExxonMobil Chemical Company
Primol 876	Naphthenic oils	ExxonMobil Chemical Company
Flexon 876	Naphthenic oils	ExxonMobil Chemical Company
Kadol oil	Refined white mineral oil	Witco
<b>Polymers / Adhesives</b>		
Escorene UL 7720	Is an ethylene vinylacetate copolymer, having about 29 weight % vinyl acetate and a melt index of 150 dg/min.	ExxonMobil Chemical Company
NSC Easymelt	Hot melt adhesive for non-woven applications.	National Starch, Bound Brook, NJ
Henkel Hot Melt 80-8368	Commercial adhesive of EVA, tackifier, and wax	Henkel Corp
Chief Hot Melt 268	Commercial adhesive of EVA, tackifier, and wax	Chief Adhesives
Advantra 9250	Commercial adhesive of ethylene/octene-1 metallocene polymers, tackifiers, and wax	Fuller
Tite Bond Wood Glue	Water based adhesive	Home Depot, Houston Texas
Dap Glue	Solvent based wood glue	Home Depot, Houston Texas
<b>Waxes</b>		
Aristowax 165	Refined petroleum wax, melting temperature: 158 -165 °F	Frank B Ross, Jersey City, NJ
AC 8 lot 500081EQ	Polyethylene wax	Honeywell, New Jersey
Paraffint H-1	Fisher-Tropsch wax, 10 mPa @ 250 °F	Moore and Munger
AR-504	Malcated PE wax acid number 41 and viscosity of 373 mPa @190 °C	Clarient
AC-540	Ethylene acrylic acid copolymer having an acid number of 40 and a viscosity of 575 cps @140° C	Honeywell, New Jersey
Polywax 2000	Polyethylene wax	Baker Petrolite
AC-1302P	Malcated polypropylene	Honeywell
P-C80	Fischer Tropsch fractionated wax	Moore and Munger
MAPP-40	Maleic modified polypropylene with acid number of 50, viscosity of 300 cps @190 °C	Chusel, Pasadena Texas
<b>Antioxidants and other additives</b>		

Irganox 1010	Phenolic antioxidant	Ciba-Geigy
Dolomite 16 mesh	sand	Supplied by Fordamin Company Ltd (UK)
Microcarb MC 50F	calcium carbonate	Supplied by Microfine Minerals Ltd (UK)
Glass beads of 3F type	Glass bead	Supplied by Sovitec SA (Belgium)
TiO <sub>2</sub> Lot : TR92	titanium dioxide	Supplied by Hunstman Tiioxide Ltd (UK)
<b>Test surfaces</b>		
Metalized acrylic coated	Metalized acrylic coated cardboard for cereal box	General Mills
Non-coated CB testliner	1250 gr/m <sup>2</sup> for vegetable trays	Kappa, Holland
Paperboard 84A	Gray poster 20 pt chipboard with 20% recycle content	Huckster Packaging and Supply, Houston, TX
Paperboard 84B	Generic posterboard clay coated newsprint	Huckster Packaging and Supply, Houston, TX
Paperboard 84C	Generic corrugated cardboard 200# stock	Huckster Packaging and Supply, Houston, TX
Inland Paper Board	High Performance box board	Inland Paper Board and Packaging Company of Rome
Black White Fabric	Printed stretch 100% Cotton with a Thread Count of 17 by 13 per square cm, a more loosely woven fabric	High Fashion Fabrics, Houston Texas
Formica	Tabls were made from standard sheet Formica	Lowe's Hardware, Houston Texas
Blue fabric	Tabls were made from Blue Stock 038C0TP 100% Cotton, Thread Count 21 by 45 per square cm with a weight of 0.022 grams per square cm, a tightly woven cotton fabric	High Fashion Fabrics, Houston Texas.
Catalog paper	Book paper bound by a hot melt process as determined from examination	Seton Catalog
NWC	Non-woven Coverstock, Paratherm PT 120/20	Lohmann, Germany
PE	Polyethylene, White Opaque Micro-embossed CO/EX film (rubber treated inside), Reference #: CM001ARIE000757-C	Tacolin Ltd, UK
Polyester (PET) construct	Polyester construct	
BOPP	Bi-axially oriented polypropylene film, 28 micron	Mobil Films, Rochester, NY
Corona treated BOPP	Corona treated bi-axially oriented polypropylene film, 28 micron	Mobil Films, Rochester, NY
PP cast film construct	A cast film.	

[00357] REXTAC RT 2730 is a copolymer of propylene, butene and ethylene having about 67.5 mole percent propylene, about 30.5 mole percent



butene and about 2 mole percent ethylene produced by Huntsman, Company. The copolymer has about 15 mole percent BB dyads, 43 mole percent PB dyads and about 43 mole percent PP dyads. The melting point is 70°C with a melting range from 25 to 116°C. the Tg is -25°C, the crystallinity is about 7 percent, the enthalpy is 10 J/g by DSC. The Mn is 8260 the Mw is 59100 and the Mz 187900 by GPC. Mw/Mn is 7.15.

**[00358]** REXTAC RT 2715 is a copolymer of propylene, butene and ethylene having about 67.5 mole percent propylene, about 30.5 mole percent butene and about 2 mole percent ethylene produced by Huntsman, Company. The copolymer has about 11 mole percent BB dyads, 40 mole percent PB dyads and about 49 mole percent PP dyads. The melting point is 76°C with a melting range from 23 to 124°C. the Tg is -22°C, the crystallinity is about 7 percent, the enthalpy is 11 J/g by DSC. The Mn is 6630 the Mw is 51200 and the Mz 166,700 by GPC. Mw/Mn is 7.7.

**[00359]** All the adhesive formulations are in weight percent, unless otherwise noted in the compositions listed in Table 18 through Table 50.

TABLE 18 Applications Formulas (percent) and Performance Values

Formulation	A	B	C	D	E	F
Example 42	80					
Escorez™5637	7	7	13	10	10	
Parafint H-1	13	13	7	10		
Example 27		80	80	80	80	
Aristowax 165					10	
Henkel Standard Hot Melt 80-8368						100
Viscosity at 190 °C (cps)	1091	870	1152	1000	945	700
SAFT, F (°C)	233 (112)	253 (123)	257 (125)	253 (123)	259 (126)	182 (83)
Set Time (sec.)	1.5	1.5	2	1	2.5	1
Percent Substrate Fiber Tear Low Temperature -12 °C, File folder	0	80	95	10	100	100

TABLE 19 Comparison of Blended aPP/scPP with branched aPP-g-scPP

Formulation	A	B	C	D	E	F	G
Example 73	100			5			
Example 74		100		39			
Example 75			100	39			
Example 29					82		
Irganox 1010				1	1		
MAPP 40				5	5		
Escorez™ 5637				7	5		
Parafilm H-1				5	7		
Henkel Standard Hot Melt 80-8368						100	
Chief Standard Hot Melt 268							100
Viscosity at 190 °C (cps)	1132	2220	328	711	812	807	1055
SAFT, F (°C)	.....	.....	.....	263 (128)	266 (130)	173 (78)	175 (79)
Set Time (sec.)	> 6	6	No adhesion	1.5- 2.0	1.5	1	1.5
Percent Substrate Fiber Tear Low Temperature -12 °C, cardboard	100	100	0	100	85	100	100
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	0	5	0	100	100	100	100

TABLE 20 Comparison of branched aPP-g-scPP with propylene/ethylene copolymers

Formulation	A	B	C	D	E	F	G	H	I	J	K
Example 41	100	90	90								
Example 16				100	90	90					
C3/C2							100	90	90		
Escorez 5637		7	3		7	3		7	3		
Paraffint H-1		3	7		3	7		3	7		
Henkel Standard Hot Melt 80-8368										100	
Chief Standard Hot Melt 268											100
SAFT, °F	204	195	198	215	198	200	198	199	179	171	185
Set Time (sec.)	6	5	2	>6	6	1.5	6	3	>6	2	1
Percent Substrate Fiber Tear Low Temperature -12 °C, Filefolder	0	100	0	100	100	0	100	60	0	100	100

[00360] The C3/C2 is a comparative example. The polymer was an ethylene/propylene copolymer with ethylene content of about 10 wt.%. This polymer was made using rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) zirconium dimethyl at a polymerization temperature of 70 °C, following the general procedure described above for example 1, except that only one catalyst was used. The polymer had a peak melting temperature of 95 °C and viscosity of 1368 cps at 190°C.

TABLE 21 Multiple Polymer and Oil Blends of branched aPP-g-scPP Polymer

Formulation	A	B	C	D	E	F	G	H	I	J
Example 26	74	69			78	72				
Example 25			74	69			78	72		
Example 23					5	9	5	9		
Irganox 1010	1	1	1	1	1<	1<	1<	1<		
Kaydol Oil	10	10	10	10	5	9	5	9		
Escorez™5637	10	10	10	10	7	6	7	6		
Parafilm H-1	5	10	5	10	5	4	5	4		
Henkel Standard Hot Melt 80-8368									100	
Chief Standard Hot Melt 268										100
Viscosity, cps 190 °C	315	120	525	445	358	262	888	724	1002	732
SAFT, F (°C)										
Set Time (sec.)	3	1.5	1.5	1	1.5	1.5	3	3	1.5	1.0
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	100	20	100	100	100	100	100	100	100	100
Percent Substrate Fiber Tear Low Temperature 5 °C, File folder	---	---	---	---	100	100	100	100	100	100

TABLE 22 Comparison of Various formulations of branched aPP-g-scPP

<b>Formulation</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>
Example 25	92.5	78.6	78.6						
Example 69		5	5						
Example 29				82	84.5	82	82		
Escorez™5400 AR 504		5				5	7		
MAPP 40			5	5	2.5	5	5		
Irganox 1010	.5	.4	.4	1	1	1	1		
Kaydol Oil		5	5						
Escorez(tm) 5637	2	1.7	1.7	5	5				
Parafint H-1	5	4.3	4.3	7	7	7	5		
Henkel Standard Hot Melt 80-8368								100	
Chief Standard Hot Melt 268									100
Viscosity at 190 °C (cps)	790	695	688	688	758	750	830	834	1050
SAFT, °F	263	>250	>250	265	266	265	265	184	171
Set Time (sec.)	2.5	2	2	1.5	1.5	1.5	1.75	1	1.5
Percent Substrate Fiber Tear Low Temperature -12 °C, cardboard	10	98	100	75	60	90	100	100	100
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	34	100	100	100	100	100	100	100	100

TABLE 23 Hard and soft aPP-g-scPP mixes with Escorez(tm) 5400

Formulation	A	B	C	D	E	F	G	H	I
Example 28	9	9	9	9	9	9	9		
Example 17	78								
Example 40		78							
Example 21			78						
Example 20				78					
Example 67					78				
Example 25						78			
Example 26							78		
Irganox 1010	1	1	1	1	1	1	1		
Escorez™5400	7	7	7	7	7	7	7		
Parafilm H-1	5	5	5	5	5	5	5		
Henkel Standard Hot Melt 80-8368								100	
Chief Standard Hot Melt 268									100
Viscosity, cps 190 °C	344	306	548	505	521	1185	404	783	1090
SAFT, (°F)									
Set Time (sec.)	3	3.5	3.5	2.5	1.5	>2	1.5	1	1.5
Percent Substrate Fiber Tear Low Temperature 5 °C, File Folder	50	50	90	65	100	100	100	100	100
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	100	100	100	100	100	100	100	100	100
Shore A Hardness	74	77	54	63	76	76	76	80	85

There is no Table 24

TABLE 25 Comparison Various Wax Types with Two Polymer Types

Formulation	A	B	C	D	E	F	G	H	I	J	K
Parafint H-1	0	10	0	0	0	0	10	0	0		
Example 29	82	82	82	82	0	0	0	0	0		
Example 62					82	82	82	82	82		
Escorez™5637	7	7	7	7	7	7	7	7	7		
Irganox 1010	1	1	1	1	1	1	1	1	1		
AC 540				10	10				5		
Polywax 2000	10							10	5		
Licowax PP 230			10			10					
Henkel Standard Hot Melt 80-8368										100	
Chief Standard Hot Melt 268											100
Viscosity, cps 190 °C	820	763	1140	1254	848	977	588	691	715	765	1131
Set Time (sec.)	0.5	1	4	2	1.5	4+	1	0.5	1	1	1.5
Percent Substrate Fiber Tear Low Temperature -12 °C, cardboard	0	0	95	50	70	100	0	0	50	100	100
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	100	0	98	100	100	100	0	5	100	100	100

TABLE 26 Formulating Response of butene-1 modified aPP-g-scPP

Formulation	A	B	C	D	E
Example 68	100		93		
Example 70		100		93	
Escorez™5637			2	2	
Parafint H-1			5	5	
Henkel Standard Hot Melt 80-8368					100
Viscosity @190 °C (cps)	563	1100	485	1140	750
Set Time (sec.)	2.5	>3	1.5	2	1
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	100	100	88	70	100

TABLE 27 Comparison of dicyclopentadiene modified aPP-g-scPP with and without diene						
Formulation	A	B	C	D	E	F
Example 28	93	100	80			
Example 71				100	93	
Escorez™ 5637	2		20		2	
Parafint H-1	5				5	
Henkel Standard Hot Melt 80-8368						100
Viscosity, cps 190 °C	390	661	205	524	502	-
Shore A Hardness	22	34	45	-	-	-
Set Time, sec	3	4	2.5	3.5	2	1
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	50	80	90	80	90	90



TABLE 28 Comparison Various aPP-g-scPP Polymer and Adhesive Blends

Formulation	A	B	C	D	E	F	G	H	I	J	K
Example 12	100	93									
Example 24			100	93							
Example 22					100	93	88				
Example 37								100	93		
Escorez™ 5637		2		2		2	4		2		
Parafint H-1		5		5		5	8		5		
Henkel Standard Hot Melt 80-8368										100	
Chief Standard Hot Melt 268											100
Viscosity, cps 190 °C	813	875	2240	1527	1240	950	797	568	497	730	1027
Set Time, sec	3	3	3	3	3.5	2.5	1.5	3.5	2.5	1	1.5
Percent Substrate Fiber Tear Room Temperature 20-25 °C, File Folder	85	95	95	95	90	90	90	90	95	90	10

TABLE 29 Example Adhesive Testing on a Variety of Surfaces

Formulation	Blend of 78% example 29, 5% Licomont AR504, 7% Escorez 5637, 5% Parafint H-1, 5% Kaydol oil. 1% Irganox 1010 was added to the blend				Henkel 80-8368 Hot Melt	
	Maximum average Force by Dot T-Peel Test, (Newtons/lbs)	Failure Type	Maximum average Force by Dot T-Peel Test (Newtons/lbs)	Failure Type		
Surface						
Cardboard 84C	24.2/5.4	Substrate Failure	16.4/3.7	Substrate Failure		
BOPP Film (Corona Treated)	19.2/4.3	Cohesive Failure	1.0/0.2	Complex jerking		
PP Film plain	13.7/3.1	Several Types	1.0/0.2	Complex jerking		
Paperboard 84B	6.0/1.3	Substrate Failure	5.3/1.2	Substrate Failure		
Paperboard 84A	4.7/1.1	Substrate Failure	4.6/1.0	Substrate Failure		
Aluminum foil	3.2/0.7	Cohesive Failure	1.3/0.3	Cohesive Failure		



Table 31

[illegible]

Table 32

Example	EX14	EX15	EX16	EX17
Catalyst #1	G	G	G	G
Catalyst #1 feed rate (mole/min)	1.77E-06	1.77E-06	1.77E-06	1.77E-06
Catalyst #2	B	B	B	B
Catalyst #2 feed rate (mole/min)	3.12E-07	3.12E-07	3.12E-07	3.12E-07
Propylene feed rate (g/min)	14	14	10	10
Ethylene feed rate (SLPM)	1.5	0.8	0.8	1.5
Hexane feed rate (ml/min)	90	90	90	90
Polymerization temperature (°C)	80	80	105	105
Mn (kg/mol)				
Mw (kg/mol)				
Mz (kg/mol)				
g' @ Mz				
T <sub>e</sub> (°C)	28.7	58.0	19.1	---
T <sub>m</sub> (°C)	73.7	99.3	57.6	-47.8
T <sub>g</sub> (°C)	-26.3	-19.4	-26.8	-19.5
Heat of fusion (J/g)	14.8	29.6	8.0	3.7
Viscosity @190 °C (cps)	23400	37120	495	481
Ethylene content (mole %)	16.9	10.7		
Catalysts				
B = rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) zirconium dimethyl				
G = di(p-triethylsilylphenyl)methylene[(cyclopentadienyl)(3,8-di-t-butylfluorenyl)hafnium dimethyl				

### Polymerization Conditions

[00362] Propylene feed at the rate of 8 lb/hr was combined with hexane at 17 lb/hr to form 25 lb/hr of reactor feed solution. Tri-n-octyl aluminum (TNOA) as a 3 wt.% solution in hexane (obtained from Albemarle) was introduced into this stream at the rate of 0.0006 lb/hr..

[00363] Catalyst and activator entered the reactor from a separate port. The catalyst solution consisted of a mixture of di(p-triethylsilylphenyl)methylene[(cyclopentadienyl)(3,8-di-t-butylfluorenyl)hafnium dimethyl (catalyst G) and rac-dimethylsilyl bis(2-methyl-4-phenylindenyl)

zirconium dimethyl (catalyst B), with 97 molar % of catalyst G. The catalyst solution was prepared by dissolving the catalyst mixture in toluene to form a 0.5 wt% solution. The activator feed stream was made up of a 0.2 wt-% solution of N,N-dimethylanilinium tetrakis(pentafluorophenyl) borate in toluene. Both the catalysts and activator were obtained from Albemarle. The catalyst and activator feed lines were configured to mix in line immediately upstream of the reactor, with an estimated contact time of 2-4 minutes. The catalyst and activator feed rates were 0.04 g/hr and 0.1 g/hr respectively.

[00364] The reactor feed was converted to polymer through two continuous stirred tank reactors in series. The temperatures of both reactors were controlled at 135 °C. The reactors were operated liquid full under 530 psig pressure. The residence time of the feed in each reactor was 45 minutes. Conversion of propylene to polymer product was about 91%.

[00365] Molten polymer was recovered from solution via two flash stages, each with a preheater. The first stage (20 psig) polymer contained about 2% solvent and the second stage (50 torr vacuum) incorporated about 800 ppm volatiles. Water was injected into the second stage flash (devolatilizer) feed to quench residual catalyst and aid with solvent stripping. The properties of the polymer and the finished adhesives are summarized in Table 33.

Table 33

Example #	PP1	PP2	PP3	PP4	PP5	PP6	PP7	PP8
Polymerization temperature (°C)	132	135	135	135	135	134	133	137
Cat1 in catalyst blend (mol%)	96	93	93	93	93	93	96	93
Catalyst in reactor feed (wppm)	3.20	4.17	4.17	4.17	4.17	4.17	4.17	3.8
Propylene in reactor feed (wt%)	28.00	29.17	29.17	29.17	29.17	28.0	28.0	30.0
Scavenger (wppm)	7.44	25	25	25	25	24	24	24
Quench water (wt%)	1.82	0.86	0.86	0.86	0.62	1.4	2.8	0
Mn (kg/mol)	18.3	17.1	13	16.7	12.3	11.4	17.3	18.5
Mw (kg/mol)	41.7	36.6	32.5	34.4	32.3	31.9	38.5	34.1
Mz (kg/mol)	76.4	68.1	61.9	61.7	64.6	61.6	71.4	69.6
g' @Mz	—	0.83	0.85	0.83	0.81	0.83	0.94	0.89
Tc (°C)	69.2	79.8	80.6	78.4	63.8	71.8	62.8	85
Tm (°C)	131	134	136	137	130	132	137	136
Heat of fusion (J/g)	15.9	25.7	30.7	28.7	38	28.2	9.5	38.6
Viscosity @190 °C (cps)	2300	1992	1382	1527	1211	1340	4235	1270
Catalyst								
B = rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) zirconium dimethyl								
G = di(p-triethylsilylphenyl)methylene(cyclopentadienyl)(3,8-di-t-butylfluorenyl)hafnium dimethyl								

[00366] All documents described herein are incorporated by reference herein, including any priority documents and/or testing procedures. As is apparent from the foregoing general description and the specific embodiments, while forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited thereby.

**Claims****We Claim:**

1. A polymer comprising at least 50 mol% of one or more C3 to C40 olefins where the polymers has:
  - a) a Dot T-Peel of 1 Newton or more on Kraft paper; and
  - b) a branching index ( $g'$ ) of 0.95 or less measured at the Mz of the polymer;
  - c) an Mw of 100,000 or less.
2. A polymer comprising at least 50 mol% of one or more C3 to C40 olefins where the polymer has:
  - a) a Dot T-Peel of 1 Newton or more on Kraft paper;
  - b) a branching index ( $g'$ ) of 0.98 or less measured at the Mz of the polymer;
  - c) a Mw of 10,000 to 60,000; and
  - d) a heat of fusion of 1 to 50 J/g.
3. A homopolypropylene or a copolymer of propylene and up to 5 mole% ethylene having:
  - a) an isotactic run length of 1 to 30,
  - b) a percent of r dyad of greater than 20%, and
  - c) a heat of fusion of 70 J/g or less.
4. The polymer of claim 1 or 3 where the polymer has an Mw of 10,000 to 100,000 and a heat of fusion of 1 to 70 J/g.
5. The polymer of claim 1 or 2 wherein the polymer comprises propylene.

6. The polymer of claim 1 or 2 wherein the polymer comprises less than 15 mole % of ethylene.
7. The polymer of any of the above claims wherein the polymer has a melt viscosity of 7000 mPa·sec or less at 190°C.
8. The polymer of any of the above claims wherein the polymer has a melt viscosity of 5000 mPa·sec or less at 190°C.
9. The polymer of any of the above claims wherein the polymer has a melt viscosity of 3000 mPa·sec or less at 190°C.
10. The polymer of any of the above claims wherein the polymer has a melt viscosity of between 500 and 3000 mPa·sec at 190°C.
11. The polymer of any of the above claims wherein the polymer has a Tg of 0°C or less.
12. The polymer of any of the above claims wherein the polymer has a Tg of -10°C or less.
13. The polymer of any of the above claims wherein the composition has a branching index ( $g'$ ) of 0.90 or less measured at the Mz of the polymer.
14. The polymer of any of the above claims wherein the polymer has an Mw of 50,000 or less and a branching index of 0.7 or less.
15. The polymer of any of the above claims wherein the SEC graph of the polymer is bi- or multi-modal.



16. The polymer of any of the above claims wherein the polymer has an amorphous content of at least 50%.
17. The polymer of any of the above claims wherein the polymer has a peak melting point between 60 and 190°C.
18. The polymer of any of the above claims wherein the polymer has a molecular weight distribution ( $M_w/M_n$ ) of at least 5.
19. The polymer of any of the above claims wherein the polymer has a crystallinity of at least 30%.
20. The polymer of any of the above claims wherein the polymer has 20 wt.% or more of hexane room temperature soluble fraction and 50 wt % or less of Soxhlet heptane insolubles.
21. The polymer of any of the above claims wherein the polymer comprises less than 3.0 mole % ethylene.
22. The polymer of any of the above claims where the polymer comprises diolefin.
23. The polymer of any of the above claims where the polymer comprises diolefin selected from the group consisting of 1,6-heptadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 1,10-undecadiene, 1,11-dodecadiene, 1,12-tridecadiene, 1,13-tetradecadiene, cyclopentadiene, vinylnorbornene, norbornadiene, ethylidene norbornene, divinylbenzene, dicyclopentadiene, polybutadienes having an  $M_w$  less than 1000 g/mol, or combinations thereof.

24. The polymer of any of the above claims where the polymer has an  $M_z/M_n$  of 2 to 200.
25. The polymer of any of the above claims wherein the polymer has an  $M_z$  of 15,000 to 500,000.
26. The polymer of any of the above claims wherein the polymer has a SAFT of 50 to 150°C.
27. The polymer of any of the above claims wherein the polymer has a Shore A hardness of 95 or less.
28. The polymer of any of the above claims wherein the polymer has a set time of 5 seconds or less.
29. The polymer of any of the above claims wherein the polymer has an  $M_w/M_n$  of 2 to 75.
30. The polymer of any of the above claims wherein the polymer has a tensile strength at break of 0.5 MPa or more.
31. The polymer of any of the above claims wherein the polymer has a melt index of 900 dg/min or more.
32. The polymer of any of the above claims wherein the polymer is a homopolymer of propylene and or a copolymer of propylene and one or more of butene, pentene, hexene, octene, nonene, and decene, wherein the copolymer comprises less than 10 mole% ethylene, and wherein the homopolymer or copolymer has a Dot T-Peel of 3 or more Newtons; a viscosity of 8000 mPasec/sec or less at 190 ° C; a branching index (g) of

0.85 or less measured at the Mz of the polymer; and an Mw of 100,000 or less.

33. The polymer of any of the above claims wherein the polymer comprises propylene, from 0 to 5 mol% ethylene, from 0 to 40 mol% of a C5 to C12 olefin, and 0 to 10 mol% of a diene.
34. The polymer of any of the above claims where the polymer comprises less than 1 mole % of ethylene and where the polymer has at least 2 mol%  $(CH_2)_2$  units.
35. The polymer any of claims 1 to 34 wherein the polymer has at least 4 mol%  $(CH_2)_2$  units.
36. The polymer any of claims 1 to 34 wherein the polymer has at least 8 mol%  $(CH_2)_2$  units.
37. The polymer any of claims 1 to 34 wherein the polymer has at least 15 mol%  $(CH_2)_2$  units.
38. The polymer any of claims 1 to 33 where the polymer comprises between 1 and 10 mole % of ethylene and where the polymer has at least  $2 + X$  mol%  $(CH_2)_2$  units, where X is the mole % ethylene.
39. The polymer any of claims 1 to 33 where the polymer comprises between 1 and 10 mole % of ethylene and where the polymer has at least  $4 + X$  mol%  $(CH_2)_2$  units.

40. The polymer any of claims 1 to 33 where the polymer comprises between 1 and 10 mole % of ethylene and where the polymer has at least  $10 + X$  mol%  $(CH_2)_2$  units.
41. The polymer any of claims 1 to 33 where the polymer comprises between 1 and 10 mole % of ethylene and where the polymer has at least  $15 + X$  mol%  $(CH_2)_2$  units.
42. The polymer any of claims 1 to 41 where the polymer has a Dot T-Peel of 5 Newton or more.
43. The polymer any of claims 1 to 42 where the polymer has a Dot T-Peel of between 10 and 2000 Newtons.
44. The polymer any of claims 1 to 43 wherein the polymer has a Dot T-Peel of between 15 and 1000 Newtons.
45. The polymer any of claims 1 to 43 wherein the polyme has an amorphous component which contains at least 3 mol%  $(CH_2)_2$  units.
46. The polymer any of claims 1 to 43 wherein the polyme has an amorphous component which contains at least 6 mol %  $(CH_2)_2$  units.
47. The polymer any of claims 1 to 43 wherein the polyme has an amorphous component which contains at least 10 mol %  $(CH_2)_2$  units.
48. The polymer any of claims 1 to 43 wherein the polyme has an amorphous component which contains at least 15 mol %  $(CH_2)_2$  units.

49. The polymer of claim 109 where the amorphous component contains at least 20 mol %  $(CH_2)_2$  units.
50. A composition comprising the polymer of any of claims 1 to 49 and one or hydrocarbon resins selected from the group consisting of aliphatic hydrocarbon resins, aromatic modified aliphatic hydrocarbon resins, hydrogenated polycyclopentadiene resins, polycyclopentadiene resins, gum rosins, gum rosin esters, wood rosins, wood rosin esters, tall oil rosins, tall oil rosin esters, polyterpenes, aromatic modified polyterpenes, terpene phenolics, aromatic modified hydrogenated polycyclopentadiene resins, hydrogenated aliphatic resin, hydrogenated aliphatic aromatic resins, hydrogenated terpenes and modified terpenes, and hydrogenated rosin esters.
51. The composition of claim 50 further wherein the hydrocarbon resin is present at 1 weight % to about 80 weight %.
52. The composition of claim 50 further wherein the hydrocarbon resin is present at less than 5% hydrocarbon resin.
53. A pellet comprising the polymer of any of claims 1 to 49.
54. A pellet comprising the composition of any of claims 50 to 52.
55. A continuous process to produce polymer of any of claims 1 to 49 comprising:
- 1) selecting a first catalyst component capable of producing a polymer having an Mw of 100,000 or less and a crystallinity of 5% or less under selected polymerization conditions;

- 2) selecting a second catalyst component capable of producing polymer having an Mw of 100,000 or less and a crystallinity of 20% or more at the selected polymerization conditions;
  - 3) contacting the catalyst components in the presence of one or more activators with one or more C3 to C40 olefins; and,
  - 4) at a temperature of greater than 100°C;
  - 5) at a residence time of 120 minutes or less;
  - 6) wherein the ratio of the first catalyst to the second catalyst is from 1:1 to 50:1;
  - 7) wherein the activity of the catalyst components is at least 50 kilograms of polymer per gram of the catalyst compounds; and wherein at least 80% of the olefins are converted to polymer.
56. The process of claim 55 wherein the first catalyst component comprises a stereospecific metallocene catalyst compound.
57. The process of claim 55 wherein the first catalyst component comprises a non-stereospecific metallocene catalyst compound.
58. The process of claim 55, 56 or 57 wherein the second catalyst component comprises a stereospecific metallocene catalyst compound.
59. The process of claim 55 wherein the first catalyst component comprises one or more of  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium dichloride,

dimethylsilyl(tetramethylcyclopentadienyl)(t-butylamido) titanium  
dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(s-butylamido) titanium  
dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(n-butylamido) titanium  
dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido)  
titanium dichloride,  
diethylsilyl(tetramethylcyclopentadienyl)(cyclododecyl-amido) titanium  
dichloride,  
diethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido) titanium  
dichloride,  
diethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium  
dichloride,  
diethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium  
dichloride,  
methylene(tetramethylcyclopentadienyl)(cyclododecyl-amido) titanium  
dichloride,  
methylene(tetramethylcyclopentadienyl)(exo-2-norbornylamido) titanium  
dichloride, methylene(tetramethylcyclopentadienyl)(cyclohexylamido)  
titanium dichloride,  
methylene(tetramethylcyclopentadienyl)(1-adamantylamido) titanium  
dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium  
dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido)  
titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium  
dimethyl,

dimethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(cyclododecylamido) titanium dichloride,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(exo-2-norbornylamido) titanium dichloride,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(cyclododecylamido) titanium dichloride,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(exo-2-norbornylamido) titanium dichloride,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(cyclododecylamido)titanium dichloride,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(exo-2-norbornylamido) titanium dichloride, dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(cyclododecylamido)titanium dichloride,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(exo-2-norbornylamido) titanium dichloride,



dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(cyclododecylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(exo-2-norbornylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(2-tetrahydroindanyl)(cyclododecylamido) titanium dichloride,  
dimethylsilyl(2-tetrahydroindanyl)(cyclohexylamido) titanium dichloride,  
dimethylsilyl(2-tetrahydroindanyl)(1-adamantylamido) titanium dichloride,  
dimethylsilyl(2-tetrahydroindanyl)(exo-2-norbornylamido) titanium dichloride,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(t-butylamido) titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(s-butylamido) titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(n-butylamido) titanium dimethyl,

dimethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido)  
titanium dimethyl,  
diethylsilyl(tetramethylcyclopentadienyl)(cyclododecyl-amido) titanium  
dimethyl,  
diethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido) titanium  
dimethyl,  
diethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium  
dimethyl,  
diethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium  
dimethyl,  
methylene(tetramethylcyclopentadienyl)(cyclododecyl-amido) titanium  
dimethyl,  
methylene(tetramethylcyclopentadienyl)(exo-2-norbornylamido) titanium  
dimethyl, methylene(tetramethylcyclopentadienyl)(cyclohexylamido)  
titanium dimethyl,  
methylene(tetramethylcyclopentadienyl)(1-adamantylamido) titanium  
dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclododecylamido) titanium  
dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(exo-2-norbornylamido)  
titanium dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(cyclohexyl-amido) titanium  
dimethyl,  
dimethylsilyl(tetramethylcyclopentadienyl)(1-adamantylamido) titanium  
dimethyl,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(cyclododecylamido) titanium  
dimethyl,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(exo-2-norbornylamido)  
titanium dimethyl,

dimethylsilyl(2,5-dimethylcyclopentadienyl)(cyclohexylamido) titanium dimethyl,  
dimethylsilyl(2,5-dimethylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(cyclododecylamido) titanium dimethyl,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(exo-2-norbornylamido) titanium dimethyl,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(cyclohexylamido) titanium dimethyl,  
dimethylsilyl(3,4-dimethylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(cyclododecylamido)titanium dimethyl,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(exo-2-norbornylamido) titanium dimethyl, dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(cyclohexylamido) titanium dimethyl,  
dimethylsilyl(2-ethyl-5-methylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(cyclododecylamido)titanium dimethyl,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(exo-2-norbornylamido) titanium dimethyl,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(cyclohexylamido) titanium dimethyl,  
dimethylsilyl(3-ethyl-4-methylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(cyclododecylamido) titanium dimethyl,

dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(exo-2-norbornylamido) titanium dimethyl,  
 dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(cyclohexylamido) titanium dimethyl,  
 dimethylsilyl(2-ethyl-3-hexyl-5-methyl-4-octylcyclopentadienyl)(1-adamantylamido) titanium dimethyl,  
 dimethylsilyl(2-tetrahydroindenyl)(cyclododecylamido) titanium dimethyl,  
 dimethylsilyl(2-tetrahydroindenyl)(cyclohexylamido) titanium dimethyl,  
 dimethylsilyl(2-tetrahydroindenyl)(1-adamantylamido) titanium dimethyl,  
 and  
 dimethylsilyl(2-tetrahydroindenyl)(exo-2-norbornylamido) titanium dimethyl.

60. The process of claim 55 wherein the second catalyst component comprises one or more of the racemic versions of:

dimethylsilyl (2-methyl-4-phenylindenyl) zirconium dichloride,  
 dimethylsilyl (2-methyl-4-phenylindenyl) zirconium dimethyl,  
 dimethylsilyl (2-methyl-4-phenylindenyl) hafnium dichloride,  
 dimethylsilyl (2-methyl-4-phenylindenyl) hafnium dimethyl,  
 dimethylsilyl bis(indenyl)hafnium dimethyl,  
 dimethylsilyl bis(indenyl)hafnium dichloride,  
 dimethylsilyl bis(indenyl)zirconium dimethyl,  
 dimethylsilyl bis(indenyl)zirconium dichloride,  
 the racemic isomers of:  
 dimethylsilanediylbis(2-methyl)metal dichloride;  
 dimethylsilanediylbis(indenyl)metal dichloride;  
 dimethylsilanediylbis(indenyl)metal dimethyl;  
 dimethylsilanediylbis(tetrahydroindenyl)metal dichloride;  
 dimethylsilanediylbis(tetrahydroindenyl)metal dimethyl;

dimethylsilanediylbis(indenyl)metal diethyl; and  
dibenzylsilanediylbis(indenyl)metal dimethyl;  
wherein the metal can be chosen from Zr, Hf, or Ti.

61. The process of any of claims 55 to 60 wherein the activator comprises an alumoxane.
62. The process of any of claims 55 to 61 wherein the activator comprises an ionizing compound.
63. The process of any of claims 55 to 62 wherein the activator comprises a non-coordinating anion.
64. The process of any of claims 55 to 60 wherein the activator comprises one or more of methylalumoxane,  
trimethylammonium tetraphenylborate,  
triethylammonium tetraphenylborate,  
tripropylammonium tetraphenylborate,  
tri(n-butyl)ammonium tetraphenylborate,  
tri(t-butyl)ammonium tetraphenylborate,  
N,N-dimethylanilinium tetraphenylborate,  
N,N-diethylanilinium tetraphenylborate,  
N,N-dimethyl-(2,4,6-trimethylanilinium) tetraphenylborate,  
trimethylammonium tetrakis(pentafluorophenyl)borate,  
triethylammonium tetrakis(pentafluorophenyl)borate,  
tripropylammonium tetrakis(pentafluorophenyl)borate,  
tri(n-butyl)ammonium tetrakis(pentafluorophenyl)borate,  
tri(sec-butyl)ammonium tetrakis(pentafluorophenyl) borate,  
N,N-dimethylanilinium tetrakis(pentafluorophenyl) borate,  
N,N-diethylanilinium tetrakis(pentafluorophenyl) borate,

N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(pentafluorophenyl) borate, trimethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate, triethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl) borate, tripropylammonium tetrakis-(2,3,4,6-tetrafluorophenyl) borate, tri(n-butyl)ammonium tetrakis-(2,3,4,6-tetrafluoro-phenyl) borate, dimethyl(t-butyl)ammonium tetrakis-(2,3,4,6-tetrafluorophenyl) borate, N,N-dimethylanilinium tetrakis-(2,3,4,6-tetrafluorophenyl) borate, N,N-diethylanilinium tetrakis-(2,3,4,6-tetrafluorophenyl) borate, and N,N-dimethyl-(2,4,6-trimethylanilinium)tetrakis-(2,3,4,6-tetrafluorophenyl) borate;

di-(i-propyl)ammonium tetrakis(pentafluorophenyl) borate;

dicyclohexylammonium tetrakis(pentafluorophenyl) borate;

triphenylphosphonium tetrakis(pentafluorophenyl) borate;

tri(o-tolyl)phosphonium tetrakis(pentafluorophenyl) borate; and

tri(2,6-dimethylphenyl)phosphonium tetrakis(pentafluorophenyl) borate.

65. The process of any of claims 55 to 64 wherein the first catalyst component is capable of polymerizing macromonomers having reactive termini; and the second component is capable of producing macromonomers having reactive termini.
66. The process of any of claims 55 to 65 further comprising diolefin.
67. The process of any of claims 55 to 65 further comprising one or more C4 to C40 dienes.
68. The process of any of claims 55 to 65 further comprising diene selected from the group consisting of 1,6-heptadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 1,10-undecadiene, 1,11-dodecadiene, 1,12-tridecadiene, 1,13-tetradecadiene, cyclopentadiene, vinylnorbornene, norbornadiene,

ethylidene norbornene, divinylbenzene, dicyclopentadiene, polybutadienes having an Mw less than 1000 g/mol, or combinations thereof.

69. The process of any of claims 55 to 65 further comprising one or more dienes selected from the group consisting of 1,6-heptadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 1,10-undecadiene, 1,11-dodecadiene, 1,12-tridecadiene, 1,13-tetradecadiene, cyclopentadiene, vinylnorbornene, norbornadiene, ethylidene norbornene, divinylbenzene, dicyclopentadiene, polybutadienes having an Mw less than 1000 g/mol, or combinations thereof.
70. The process of any of claims 55 to 69 wherein the reaction zone is a gas phase reactor.
72. The process of any of claims 55 to 69 wherein the reaction zone is a solution phase reactor.
73. The process of any of claims 55 to 69 wherein the reaction zone is a slurry phase reactor.
74. The process of any of claims 55 to 69 wherein the reaction zone is a solution phase reactor.
75. The process of any of claims 55 to 74 where the catalysts comprise one or more of the following combinations (where Me equals methyl, Ph equals phenyl, Et equals ethyl, Cp equals cyclopentadienyl, 3,8-di-t-BuFlu equals 3,8-di-tert-butylfluorenyl, 2-Me-4-PhInd equals 2-methyl-4-phenylindenyl, 2-MeInd equals 2-methylindenyl,  $c\text{-C}_{12}\text{H}_{23}$  equals cyclododecyl,  $\text{Me}_4\text{C}_5$  equals tetramethylcyclopentadienyl,  $\text{H}_4\text{Ind}$  equals tetrahydroindenyl, and Ind equals indenyl):

- (1)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (2)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator,
- (2a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (3)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (4)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator,
- (4a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-c-C}_{12}\text{H}_{23})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (5)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamanty})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (6)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamanty})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (6a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamanty})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium}$



tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;

- (7)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamantyl})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$   
activated with an alumoxane;
- (8)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamantyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (8a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-1-adamantyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with N,N-dimethylanilinium  
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (9)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$   
activated with an alumoxane;
- (10)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (10a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with N,N-dimethylanilinium  
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (11)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2$  activated  
with an alumoxane;
- (12)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$   
activated with a non-coordinating anion activator;

- (12a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-t-butyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$   
activated with N,N-dimethylanilinium  
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (13)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (14)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (14a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with N,N-dimethylanilinium  
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (15)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (16)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (16a)  $\text{Me}_2\text{Si}(\text{Me}_4\text{C}_3)(\text{N-exo-norbornyl})\text{TiMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with N,N-dimethylanilinium  
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (17)  $(\text{p-Et,SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-t-BuFlu})\text{HfCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$  activated with an alumoxane;

- (18)  $(p\text{-Et}_3\text{SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-}t\text{-BuFlu})\text{HfMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (18a)  $(p\text{-Et}_3\text{SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-}t\text{-BuFlu})\text{HfMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (19)  $(p\text{-Et}_3\text{SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-}t\text{-BuFlu})\text{HfCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (20)  $(p\text{-Et}_3\text{SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-}t\text{-BuFlu})\text{HfMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (20a)  $(p\text{-Et}_3\text{SiPh})_2\text{C}(\text{Cp})(3,8\text{-di-}t\text{-BuFlu})\text{HfMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (21)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrCl}_2$  activated with an alumoxane;
- (22)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (22a)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;

- (23)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (24)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (24a)  $\text{meso-CH}_2\text{CH}_2(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (25)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrCl}_2$  activated with an alumoxane;
- (26)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (26a)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(\text{H}_4\text{Ind})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;
- (27)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (28)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;
- (28a)  $\text{meso-Me}_2\text{Si}(\text{Ind})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  activated with  $\text{N,N-dimethylanilinium tetrakis(pentafluorophenyl)boron}$  and or  $\text{triphenylcarbonium tetrakis(pentafluorophenyl)boron}$ ;

- (29)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$   
activated with an alumoxane;
- (30)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$   
activated with a non-coordinating anion activator;
- (30a)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$   
activated with  $\text{N,N-dimethylanilinium}$   
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (31)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrCl}_2$   
activated with an alumoxane;
- (32)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$   
activated with a non-coordinating anion activator;
- (32a)  $\text{meso-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-MeInd})_2\text{ZrMe}_2$   
activated with  $\text{N,N-dimethylanilinium}$   
tetrakis(pentafluorophenyl)boron and or triphenylcarbonium  
tetrakis(pentafluorophenyl)boron;
- (33)  $\text{meso-CH}_2\text{CH}_2(2\text{-MeInd})_2\text{ZrCl}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrCl}_2$  activated with an alumoxane;
- (34)  $\text{meso-CH}_2\text{CH}_2(2\text{-MeInd})_2\text{ZrMe}_2$  and  $\text{rac-Me}_2\text{Si}(2\text{-Me-4-PhInd})_2\text{ZrMe}_2$  activated with a non-coordinating anion activator;